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V. W. PETERSON ET AL

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PISTON OPERATED PRESS AND THE LIKE

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Fig. 1

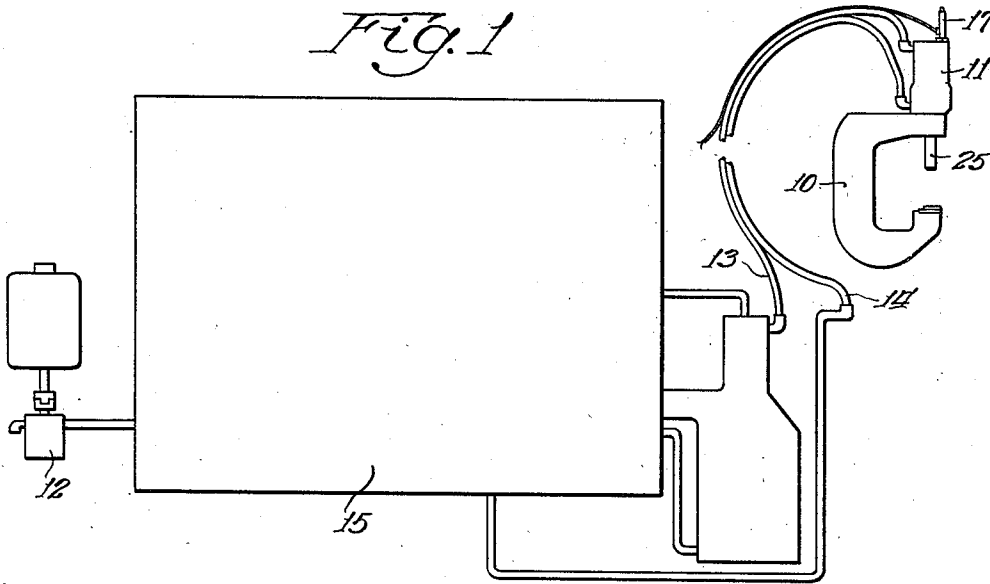
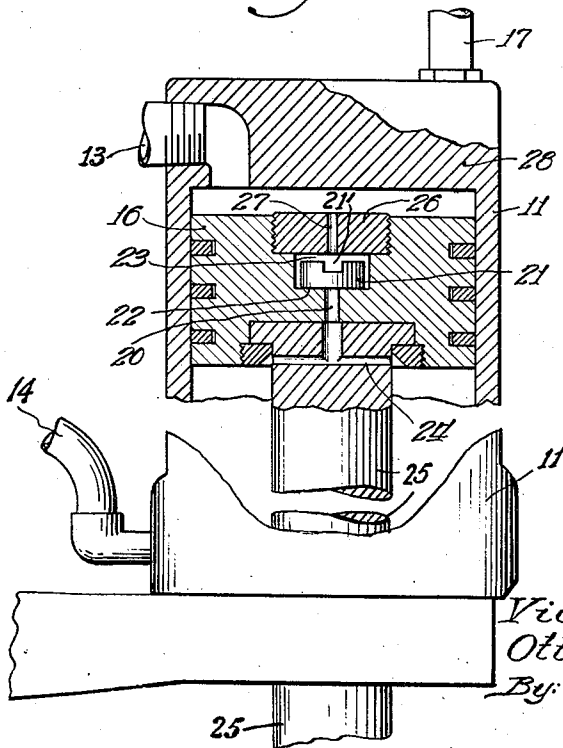


Fig. 2



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PISTON OPERATED PRESS AND THE LIKE

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3 Claims. (Cl. 121—38)

This invention relates to piston operated presses and the like, and among other objects aims to provide means for improving the operation of the piston.

The nature of the invention may be readily understood by reference to one illustrative embodiment thereof shown in the accompanying drawing.

In said drawing:

Fig. 1 is an elevation, somewhat diagrammatic in form, of a yoke riveter connected to a pressure supply mechanism; and

Fig. 2 is an enlarged section of the operating piston and a portion of the cylinder.

In piston operated presses and the like, the plunger is generally given a stroke substantially greater than that in which its work is performed, in order, among other objects, to allow the plunger to clear the work and to facilitate placing and removing of the articles operated on. It is desirable, however, to curtail the time consumed in the idle portions of the forward and return stroke by shortening the return stroke when a longer stroke is, for any reason, unnecessary. For example, if the piece of work operated upon is small and easily moved into and out of operating position, the return stroke may be much shorter than for a large piece of work or one which is not so readily placed in and removed from the press. Again, in riveting where the rivets are close together, a rapid sequence of operations is possible and the return stroke may advantageously be shortened to an amount just sufficient to allow shifting from one rivet to the next. Under the foregoing and other circumstances, a new cycle of operations is advantageously started immediately and without the delay which would ensue while the plunger returned the remainder of its stroke and then advanced by the same amount.

The invention is here shown embodied in a hydraulic yoke riveter 10, but it will be understood that its use is not limited to riveting presses. The hydraulic pressure (preferably oil pressure) is supplied to the riveter cylinder 11 from any appropriate pressure supply means which may include a rotary pump 12. Lines 13 and 14, leading from the pressure supply means, are connected respectively to the opposite ends of the press cylinder to supply and return pressure liquid.

The pressure supply means should be capable of developing pressures sufficiently high to perform the work required. Higher operating speeds, greater efficiency, and reduction in power

and weight may be secured by employing intensifying means 15 by which pressures substantially higher than the maximum pump pressure, may be developed during the short interval in which the plunger is performing its work. The relatively lower pump pressures will serve to advance the plunger into contact with the work and to withdraw the plunger from the work. Pressure intensifying mechanism such as that disclosed in our co-pending application, Serial No. 91,630, now Patent No. 2,241,645, may be employed. It should be understood, however, that the invention is not limited to any particular pressure intensifying mechanism, nor indeed, to presses employing intensified pressure since many operations may be performed with relatively low pump pressures. During the forward stroke of the plunger line 14 is open to discharge and on the return stroke line 13 is open to discharge.

In riveting operations for cold heading, for example, a $\frac{3}{8}$ -in. rivet, the pump should be capable of supplying oil pressures up to approximately 1,000 lbs. per square in. with a capacity of about 1 cu. ft. per minute. Such pressure and capacity are employed to advance the riveter plunger quickly to engagement with the work and to remove all slack from the system prior to the application of intensified pressure which functions only to complete the heading of the rivet. Indeed, the direct pump pressure is generally sufficient partially to head the rivet. The intensified pressures may reach 5,000 lbs. per square in.

When the rivet is headed, the stroke of the plunger piston 16 is reversed (either automatically or manually) by application of pressure to the opposite face of the piston through the return line 14. Unless interrupted, the piston will be returned to engagement with the cylinder head, at which time the return pressures will be built up sufficiently to neutralize the pressure supply mechanism in preparation for the commencement of a new cycle which is inaugurated when the operator presses the starting button 17.

The mechanism for interrupting the plunger stroke and for starting a new stroke need not be limited to any specific devices. That disclosed in the aforesaid co-pending application may be employed. It comprises a simple electric push button switch like the switch 17 to operate a solenoid, controlling the starting and stopping of a cycle of operations. The cycle continues so long as the solenoid is energized but when the push button is released and the solenoid de-energized, the cycle is interrupted and pressure

is supplied to return line 14 to start piston 16 on its return stroke. Another cycle can be started at any point on the return stroke simply by depressing the push button.

As a practical matter, however, if the return speed of the plunger be too great, it is difficult to interrupt its return in mid-stroke, in which event the next operation is delayed until the plunger has traversed the idle or unnecessary portion of its return stroke. Among other advantages, the illustrative apparatus effects such retardation of the return plunger stroke and acceleration of the forward stroke as to minimize idle time and secure efficient operation. In riveting operations, for example, the time consumed in idle travel (backward and forward) of the plunger should not greatly exceed the time consumed in shifting the riveter from one rivet to the next. In the present instance, the accelerated forward and retarded return speeds of the plunger are secured by by-passing a portion of the pressure liquid around or through the piston.

As here shown, piston 16 is provided with a by-pass passage 20, leading from one face to the other. The passage is controlled by a valve 21 which serves to close the passage when the oil pressure on the head or operating face of the piston exceeds that on the opposite face. The valve is here shown in the form of a disc adapted to seat against the face 22 of recess 23 to close the passage 20. The passage 20 in this case communicates with the return side of the piston through a passage 24 in plunger 25. The recess 23 in which the valve disc 21 is seated is closed by a plug 26, having a passage 27 connecting the valve chamber 23 with the cylinder space.

The forward speed of the plunger and its piston 16 depends to some extent upon the rate at which the liquid below the piston can be displaced and also on the rate at which the larger volume of liquid can be forced into the head end of the cylinder 11. Such forward speed is therefore accelerated by by-passing or displacing a portion of the liquid simply from the lower portion of the cylinder to the head end, thereby minimizing the volume of liquid required to travel to discharge through the supply and return lines 13 and 14 and their associated valves and passages. The latter displacement occurs (notwithstanding the total pressure differential which causes the piston to advance) because the unit pressure on the head end of the piston is actually less than that on its opposite face, thereby raising valve 21 and short-circuiting a portion of the liquid. In passing into the head end of the cylinder, the by-passed liquid, because of its greater pressure, actually performs work on the piston, hastening its advance. Despite the lower unit pressure on the head end of the piston, the total pressure thereon is greater than on its opposite face because of the former's substantially greater area, the plunger 25 reducing the effective area of the opposite face of the piston. In the present instance, the area of the head end is about 7 sq. in., whereas the effective area of the opposite face is only about 5 sq. in.

It should be understood that the aforesaid unit pressure on the under face of the piston develops as a result of the resistance of the liquid to discharge from the cylinder through line 14. When, however, the plunger engages work, the highly increased resistance to further advance automatically results in the building up of the

unit pressure on the head end of the piston to a point where it substantially exceeds that on the opposite face, thereby closing valve 21 and holding it tightly on its seat to prevent further short-circuiting of the liquid.

To return the plunger after completion of its operation, oil pressure is shifted to return line 14, line 13, of course, being opened to discharge. The unit pressures on the underside of the piston then very substantially exceed those in the head end of the cylinder (since it is now open to discharge), again opening valve 21. However, as contrasted with former conditions, the liquid now passes into the end of the cylinder (i. e. the head end) from which liquid must be displaced to permit return of the piston, and greatly increases the volume to be displaced. The substantial increase in the volume of liquid to be discharged of course causes an increase in the back pressure or resistance to such discharge and thereby substantially retards the return stroke of the piston and allows sufficient time interval within which to operate the button 17 to interrupt return and start a new cycle.

The speed of return of the piston may be varied by employing plugs 26 with a larger or smaller passage 27. If passage 27 be more restricted, the speed of return will be increased; if larger, it will be retarded. Indeed, if it be too large, the piston will not be returned since there would be insufficient resistance to the travel of the fluid through the passage to develop a pressure differential below the piston. Hence passage 27 must always be restricted sufficiently to develop the necessary pressure differential.

The upper face of valve 21 is slotted or otherwise is provided with a passage 21' so as not to close access to passage 27.

If the piston be permitted to complete its return stroke, engagement with the cylinder head 28 serves to close passage 27, thereby making it possible (as in the apparatus of said co-pending application) to utilize the building up of the return line pressures to a predetermined value to actuate control devices which operate to cut off pressure supply and condition the apparatus for starting another cycle. For this purpose, the end of plug 26 is ground so that it seats tightly against the cylinder head surface in order effectively to close passage 27 and thereby shut off further by-passing of liquid to the head end of the cylinder. The maximum stroke of the piston may be reduced if desired in any case by inserting in the cylinder head a plug which projects inwardly an amount equivalent to the desired shortening of the stroke. The end of the plug is ground and functions in place of the cylinder head for causing neutralization of the pressure supply apparatus and for closing passage 27.

When it is possible, as in the present design, to interrupt the return stroke at any point and immediately start the piston on the forward stroke of a new cycle, the time consumed by the piston in unnecessary return and forward movements and operations incident thereto is, of course, eliminated.

The by-passing of the oil around the piston when the valve 21 is open also advantageously provides oil circulation between both faces of the piston, thereby dissipating heat which would otherwise accumulate in the cylinder through non-circulation and also dissipating the air which may be trapped above and below the piston.

It should be understood, of course, that the valve controlled by-pass need not be placed in the piston, but may be incorporated in lines connected with the cylinder and extending from one side of the piston to the other.

If mobility of the press be desirable, as in riveters, the unit may be connected to the pressure supply means by flexible hose lines 13 and 14. Flexible hose, capable of transmitting the aforesaid high pressures without excessive expansion or distortion, may be secured upon the open market. One satisfactory type embodies a reinforcing of woven wire wherein the strands run diagonally or spirally around the hose and are covered with a rubberized protective fabric. The inside of the hose is lined with a flexible leakproof composition. The wire reinforcing, although quite flexible, is of such strength as to prevent undue expansion of the hose under pressure, thereby minimizing the volume of fluid (and waste energy) consumed in expansion or stretching of portions of the apparatus under the high pressures developed.

Additional mobility in a yoke riveting press, for example, may be secured by making the yoke or frame of a heat-treated alloy steel having a strength of about 200,000 lbs. per sq. in. and capable of withstanding working stresses up to about 125,000 lbs. For cold heading a $\frac{3}{8}$ in. rivet, where the maximum heading pressure exerted by the riveter plunger is about 35,000 lbs., the use of steel of this character makes it possible to make a yoke riveter which, with the piston riveting tool and cylinder, weighs only about 50 lbs. and which, therefore, may be maneuvered more easily and quickly than heretofore from one rivet to the next. Moreover, the small size of the riveter makes it possible to reach rivets which have, heretofore, been inaccessible for cold heading.

Obviously the invention is not limited to the details of the illustrative construction since these may be variously modified. Moreover it is not indispensable that all features of the invention be used conjointly, since various features may be used to advantage in different combinations and sub-combinations.

Having described our invention, we claim:

1. In apparatus of the character described, the combination comprising a work cylinder having a double-acting piston and plunger, control mechanism for opening the head end of said cylinder to discharge and for delivering pressure fluid to the plunger end to move the piston on its return stroke, a by-pass for passing fluid from the plunger end of said cylinder to the head end thereof on the return stroke to increase the volume of fluid to be discharged from said head end and thereby retard the return movement of said piston, said by-pass being restricted to develop pressure on the plunger face of said piston sufficient to move said piston, and a check valve in said by-pass to prevent travel of fluid from said head end to said plunger end.

2. In apparatus of the character described, the combination comprising a work cylinder having a double-acting piston and a work plunger, said plunger reducing the effective area of the plunger side of said piston so that said piston may be caused to advance with unit pressure in the head end less than the unit back pressure in the plunger end of said cylinder, control mechanism for opening the head end of said cylinder to discharge and for delivering pressure fluid to the plunger end and vice versa, a by-pass for passing fluid from the plunger end to the head end of said cylinder on the forward stroke of the piston, a check valve in said by-pass operative to close said by-pass when the unit pressure in the head end of said cylinder exceeds that in the plunger end thereof, said by-pass also passing fluid from the plunger end of said cylinder to the head end thereof on the return stroke to increase the volume of fluid to be discharged from said head end and thereby retard the return movement of said piston, said by-pass being restricted to develop pressure on the plunger face of said piston sufficient to move said piston, and means for closing said by-pass when said piston reaches the end of its return stroke.

3. In apparatus of the character described, the combination comprising a work cylinder having a double-acting piston and a work plunger, said plunger reducing the effective area of the plunger side of said piston relative to that of its opposite face so that said piston may be caused to advance with a total pressure exceeding the total back pressure but with unit pressure in the head end less than the unit back pressure in the plunger end of said cylinder, control mechanism for delivering pressure fluid to the head end of said cylinder and for opening the plunger end to discharge and for maintaining said plunger end open to discharge throughout the advance stroke of said piston, said control mechanism also operating to deliver pressure fluid to said plunger end and to open said head end to discharge for the return stroke of said piston, means for increasing the speed of advance of said piston including a by-pass for by-passing fluid from the plunger end to said head end on the advance stroke of said piston in addition to the fluid simultaneously passing to discharge, said by-pass being restricted to permit the development of pressure on the piston adequate to return the piston against back pressure thereon, and a check valve in said by-pass to prevent flow from said head end to said plunger end, said check valve also being adapted to interrupt flow through said by-pass when through increase in resistance to advance of said plunger unit pressure in said head end exceeds the unit back pressure in said plunger end.

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